**PATENT APPLICATION**
Attorney Docket: 10030978-3

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**
**BEFORE THE BOARD OF APPEALS**

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| Applicant: | Dunsmore, et al |
| Serial No.: | 10/537,031 |
| Filed: | 5/31/2005 |
| For: | Correcting Test System Calibration and Transforming Device Measurements When Using Multiple Test Fixtures |
| Group Art Unit: | 2138 |
| Examiner: | Merant, Guerrier |

**BRIEF FOR APPELLANT**

Commissioner For Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This is an appeal from the decision of the Primary Examiner dated 7/27/2007, finally rejecting Claims 1-14 and 21-31 in the above-identified patent application.

## I. REAL PARTY IN INTEREST

The real party in interest is Agilent Technologies, Inc. having an address as shown below.

## II. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to appellant, the appellant's legal representative, or assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in this pending appeal.

## III. STATUS OF THE CLAIMS

Claims 1-32 are currently pending in the above-identified patent application. In the Office Action dated 7/27/2007, the Examiner rejected Claims 1-14 and 21-31 and indicated that the Action was final. Claims 15-20 and 32 have been allowed.

## IV. STATUS OF AMENDMENTS

No amendments have been filed since the final Office Action dated 7/27/2007.

## V. SUMMARY OF THE CLAIMED SUBJECT MATTER

This invention addresses situations in which the performance of a device under test (DUT) is measured with the DUT interfaced to a test system by one test fixture, but it is desirable to determine what the DUT performance would have been if a second test fixture were able to be used instead. One fixture may, for example, be a relatively expensive laboratory instrument while the other fixture may be some relatively inexpensive and compact fixture used on a manufacturing production line.

In the real world, each of the test fixtures introduces errors into the measurements performed on the DUT. Various prior art schemes to correct for the errors made by a test fixture have been put forward; however, these modeling schemes typically do not provide complete correction for the errors over the full range of operating parameters that are being tested. The present invention avoids this problem by relating the measurements made with one imperfect test fixture to those made by a second imperfect test fixture so that the measurements can be compared with one another. The present invention does not require a detailed knowledge of the underlying mechanisms that give rise to the errors.

There are two independent method claims of concern in this appeal, claims 1 and 26, and one independent system claim, claim 21. With respect to claim 1, refer to Figure 1 and the discussion thereof that begins on page 8, line 3 of the specification. The claimed invention is a method of transforming measurements, beginning at step 110 with determining a port-specific difference array, whose elements are obtained by measuring the performance of a set of devices – typically a set of calibration standards - when connected in turn to one specific port, say port A1, of a first test fixture and to one specific port, say port B1, of a second test fixture. At step 120, the performance of the DUT is measured using the same port, B1, of the second (or production) test fixture. At step 130, the port-specific difference array is applied in

a way that results in the measurements made at step 120 approximating those that could hypothetically have been made if the DUT had been connected to port A1 of the other test fixture. Step 120 may be repeated for other possible pairings of ports between first and second test fixtures, resulting in multiple port-specific difference arrays that may then be used in step 130.

Claim 2 specifies that the port-specific difference array determined in step 110 is an error adaptor that is applied to the measured performance of the DUT to essentially remove an effect of a port portion of the second test fixture and to add an effect of a corresponding port portion of the first test fixture on the measured performance. Figure 2 and the associated text beginning at line 12 on page 14 of the specification shows the effect of port portions 211, 213 and 213 of the test fixture 210 on measurements of the DUT 220.

Claim 3 can best be understood by referring to Figure 4. The claim requires that the port-specific difference array is determined by measuring characteristics of a set of calibration standards at corresponding ports of the first test fixture (at 112a) and the second test fixture (at112b) by separately inserting each calibration standards of the set in each test fixture at a respective port; and solving for elements of the difference array (at 114b) using results obtained from measuring characteristics of the calibration standard set for each test fixture. Claims 8-14 depend from claim 3.

Claim 8 additionally requires that the calibration standards used in step 112 connect corresponding pairs of ports to one another for each test fixture, such that all combinations of ports in each test fixture are separately connected as pairs for measuring the characteristics. This case is illustrated in Figure 5. The additional requirement of claim 9 is that the measuring step 112 comprises measuring a reflection parameter of each standard of the set of calibration standards separately for each port of the first test fixture, and measuring a reflection parameter of each standard of the set of calibration standards separately for each corresponding port of the second test fixture, wherein one or more of the standards of the set isolate the respective port from other ports of the respective test fixture. Claim 10 specifies that the measuring step 112 comprises measuring S-parameters for each standard of the set of calibration standards separately for each port pair of the first test fixture; and measuring S-parameters for each standard of the set of calibration standards separately for each port pair of

the second test fixture; wherein the standards of the set are thru standards that connect pairs of ports together to form the port pairs. Figure 6A shows an example of part of the setup for this, with thru standard 301 connecting ports Port-1 and Port-2 of test fixture 300.

Claim 11 adds further details of step 114 of Figure 4, specifying that the solving comprises solving several equations for several unknowns using the measured results, the solved unknowns representing the difference array elements. Claim 12 adds different details to step 114 of Figure 4, specifying that the solving comprises optimizing a model using the measured results for each test fixture, the model representing one or more of the port-specific difference arrays, wherein optimizing comprises adjusting parameters of the model until a difference between test fixture measurements is minimized, the test fixture measurements being converted measurements of the second test fixture produced by the model using the measured results for the second test fixture and the measured results for the first test fixture, the model parameters representing the elements of the difference array. Claim 13 adds the requirement that measuring and solving steps 112 and 114 of Figure 4 are repeated for each port or each pair of ports of each of the test fixtures. Claim 14 adds the requirement that the solving step 114 comprises determining a complex square root of one of the elements, wherein the square root is determined using data representing the element at more than one frequency.

Claims 4 and 5 depend from claim 1 and give more details on step 130 of Figure 1, the application of the port-specific difference array to the measurements made at step 120. Claim 4 requires that the measured DUT performance is directly transformed into the approximation of the hypothetical performance. Claim 5 requires that a calibration of a test system is modified such that the measured performance of the DUT produced using the test system is the hypothetical measured performance. This method is shown in Figure 8. Claim 6 depends from claim 1 and further specifies that the performance of at least one of the test fixtures and one of the calibration standards involved in carrying out step 110 to determine the port-specific difference array, may be unknown or poorly known. Claim 7 depends from claim 1 and further specifies that the determining step, 110,110’ in Figure 1 or 610, 610’ in Figure 9, employs measurements of the test fixtures at a plurality of frequencies in a frequency range of interest for the DUT.

Claims 21-25 concern test systems for carrying out the methods described above. With respect to claim 21, refer to figure 7 and the discussion thereof that begins on page 28 at line 4 of the specification. The claimed invention is a test system 400 comprising test equipment 410, a test fixture 430 that interfaces the DUT to the test equipment, a computer 440 connected to receive and process data from the test equipment; and a computer program 450. The computer program comprises instructions concerning the determination of a port-specific difference array that adjusts for a difference between a first test fixture and a second test fixture, depending on which of the two is used to interface the DUT to the test system.

Claims 22-24 depend from claim 21 and give additional details on the instructions of computer program 450. Claim 22 specifies instructions that implement measuring a performance of the DUT when the DUT is connected to the test equipment using the second test fixture; and instructions that implement applying the difference array to correct or adjust the measured performance of the DUT, such that the DUT performance measured using the second test fixture approximates a hypothetical DUT performance as if measured using the first test fixture to interface the DUT to the test equipment. Claim 23 depends from claim 22 and further specifies that the instructions that implement applying comprise applying the difference array directly to the measured performance of the DUT produced by the test system to transform the measured DUT performance into the hypothetical DUT performance. This results in a system that substantially carries out the method of claim 4. Claim 24 depends from claim 22 and further specifies that the instructions that implement applying comprise applying the difference array to a calibration of the test equipment to correct calibration coefficients of the test equipment, such that the measured performance of the DUT is equivalent to the hypothetical DUT performance. This results in a system that substantially carries out the method of claim 5.

Claim 25 depends from claim 21 and further requires instructions that implement determining a complex square root of an element of the difference array using values of the element at a plurality of frequencies. Figure 9 shows the general determining step 610, 610' in cases where measurements are made at a plurality of frequencies.

With respect to claim 26, refer to Figure 9 and the description thereof that begins on page 30 at line 8 of the specification. Claim 26 covers steps 610 and 610' which determine a

port-specific difference array based on measurements made at a plurality of frequencies. An element of the difference array is determined by connecting a set of calibration standards via first and second test fixtures to the test system and making measurements at a plurality of frequencies.

Claim 27 additionally includes step 620 of Figure 9, specifying that the port-specific difference array is applied to transform measurements made using the second test fixture into those that could hypothetically have been made if the first test fixture had been used. Claims 28-31 depend from claim 27 and add details concerning the determination of elements of the port-specific difference array in step 610, 610' based on measurements at a plurality of frequencies. Claim 28 requires that a model is optimized across the plurality of frequencies using the calibration standard measurements. Claim 29 requires that the element is determined from a complex square root of a term of a port-specific error adaptor determined from the calibration standard measurements, the complex square root being computed using a plurality of values of the error adaptor term that corresponds to the plurality of frequencies.

Claim 30 depends from claim 29 and further specifies that computing the complex square root comprises unwrapping a phase portion of data points representing the element at different frequencies to produce phase-unwrapped data points; dividing a wrap-normalized phase of the data points by two to yield a phase portion of the square root; and computing a positive real-valued square root of magnitudes of the data points to produce a magnitude portion of the square root. Claim 31 depends from claim 30 and further specifies that before dividing a wrap-normalized phase: a group delay of the phase-unwrapped data points is estimated, and a number of complete phase wraps associated with a first data point is removed from the phase portion of the phase-unwrapped data points to produce data points having the wrap-normalized phase, the number of complete phase wraps being computed using the estimated group delay.

## VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

**The rejection of Claims 1-14 and 21-31 under 35 U.S.C. 102(e) as being anticipated by Dunsmore (US 6,643,597).**

## VII. ARGUMENT

### A. Examiner's Burden under 35 U.S.C. 102

The Examiner has the burden of showing by reference to the cited art each claim limitation in the reference. Anticipation under 35 U.S.C. 102 requires that each element of the claim in issue be found either expressly or inherently in a single prior art reference. In re King, 231 USPQ 136, 138 (Fed. Cir. 1986); Kalman v. Kimberly-Clark Corp., 218 USPQ 781, 789 (Fed. Cir. 1983). The mere fact that a certain thing may result from a given set of circumstances is not sufficient to sustain a rejection for anticipation. *Ex parte Skinner*, 2 USPQ2d 1788, 1789 (BdPatApp&Int 1986). "When the PTO asserts that there is an explicit or implicit teaching or suggestion in the prior art, it must indicate where such a teaching or suggestion appears in the reference" (*In re* Rijckaert, 28 USPQ2d, 1955, 1957).

Under the doctrine of inherency, if an element is not expressly disclosed in a prior art reference, the reference will still be deemed to anticipate a subsequent claim if the missing element "is necessarily present in the thing described in the reference" Cont'l Can Co. v. Monsanto Co., 948 F.2d 1264, 1268, 20 USPQ2d 1746, 1749(Fed. Cir. 1991). "Inherent anticipation requires that the missing descriptive material is 'necessarily present,' not merely probably or possibly present, in the prior art." Trintec Indus., Inc. v. Top-U.S.A. Corp., 295 F.3d 1292, 1295, 63 USPQ2d 1597, 1599(Fed. Cir. 2002) (quoting In re Robertson, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999)).

### B. Rejection of claims 1 and 26 and the claims dependent therefrom

Claims 1 and 26 require the determination of a port-specific difference array, the difference array describing a difference between a first test fixture and a second test fixture at a corresponding test port of the test fixtures. The Examiner points to Dunsmore (col. 13, lines 5-20; col. 14, lines 47-67 and col. 15, lines 1-13) as teaching this limitation, identifying element 140 of Figure 1 as the "the port-specific difference array that is created to record the difference between the test fixture (item 430A, Fig. 5) and a standard (item 420, Fig. 5)".

Applicant submits that the cited passages do not teach the claim limitations. Figure 1 of Dunsmore and the cited passages simply teach that element 140 is a "calibration array" that

is created using the test fixture and models for the standards after the models have been optimized by the earlier steps of calibration method 100. Applicant submits that the cited passages do not teach either that 140 is a port-specific difference array, or that the differences in question are the differences between first and second text fixtures at a corresponding test port of the test fixture.

First, regarding the requirement that the array is a difference array, Applicant submits that the teaching in Dunsmore regarding differences (for example in column 13, lines 52-67, and in claim 12) concerns the use of differences between simulation and measured values in determining the minimization metrics used to optimize the models,. These differences are used to adjust the element values in the models, and are not themselves incorporated into the models. Applicant submits that the Examiner has not pointed to any teaching that these differences appear as elements of array 140.

Second, even if calibration array 140 taught by Dunsmore were taken to represent differences of some kind, the Examiner states that the differences would be those between test fixture 430A and standard 420, but the claim requires differences between two test fixtures. Hence, the Examiner must be assigning the calibration standard 420 as the second test fixture. Dunsmore teaches in Figure 5 and the related passage (col. 18, lines 21-31) that 420 is a set of calibration standards, such as, for example, a short, an open, a load, and a thru (SOLT). Dunsmore also teaches that a test fixture is an element that provides an electrical and mechanical interface (col. 7, lines 12-26) either **between the test system and the calibration standards** (Figure 5 and col. 18, lines 58-61) or **between the test system and the DUT** (Figure 5 and col. 18, lines 32-42). Hence, the standards identified by the Examiner could not be a second test fixture, since the standards are not used to connected the DUT to the test system. Moreover, the claims require that the DUT is measured when mounted in the second test fixture. There is no teaching in Dunsmore that the DUT is even mounted in the calibration standard, or connected to it during any measurement process. In this regard, it should be noted that the calibration standard is used in place of the DUT during certain calibration operations.

Accordingly, Applicant submits that even if array 420 were to represent differences between calibration standard 420 and test fixture 430A, as suggested by the Examiner, it would not represent differences between two test fixtures, as the claims require.

Hence, Applicant submits that Dunsmore does not anticipate claims 1, 26, or the claims dependent therefrom.

**C. Additional arguments for claims 2-3, 11 and 13, which depend from claim 1**

In rejecting claims 2-3, 11, and 13, the Examiner points to column 14, lines 61-67, column 15, lines 1-13, column 18, lines 55-67, and column 19, lines 1-10 as teaching that "the determined port-specific difference array is an error adaptor that is applied to the measured performance of the DUT to essentially remove an effect of a port portion of the second test fixture and to add an effect of a corresponding port portion of the first test fixture on the measured performance". First, Applicant submits that the limitation which the Examiner discusses here is relevant only to Claim 2, not Claims 3, 11, and 13. Second, Applicant disagrees with the Examiner's reading of Dunsmore as teaching all the limitations of Claim 2.

First, as discussed above with respect to Claim 1, Dunsmore does not teach the limitation relating to determining a port-specific difference array. Second, claim 2 additionally requires that array to be applied to the DUT measurements to remove an effect of a port portion of the second test fixture and to add an effect of a corresponding port portion of the first test fixture. Applicant submits that the passages to which the Examiner points discuss models and their optimization, but do not disclose that any difference array is applied, nor that the calibration that is described therein has the effects regarding port portions of text fixtures that are required by the claim. Hence, Applicant submits that there are additional grounds for allowing claim 2.

Claim 3 requires that characteristics of a set of calibration standards are measured at corresponding ports of the two test fixtures by separately inserting each calibration standard of the set in each test fixture at a respective port; and solving for elements of the difference array using results obtained from measuring characteristics of the calibration standard set for each test fixture. Applicant submits that the passages to which the Examiner points discuss

models and their optimization, but do not disclose the measurement of calibration standards in the manner specified by this claim. Hence, Applicant submits that there are additional grounds for allowing claim 3 and the claims dependent therefrom.

Claim 11 requires that several equations are solved for several unknowns using the measured results, the solved unknowns representing the difference array elements. The passages to which the Examiner points discuss models and their optimization, but do not disclose the solving of several equations for several unknowns representing difference array elements. Hence, Applicant submits that there are additional grounds for allowing claim 11.

Claim 13 requires that the measuring and solving are repeated for each port or each pair of ports of each of the test fixtures. The passages to which the Examiner points discuss models and their optimization, but do not disclose the measuring and solving for each port or each pair of ports of each test fixture. Hence, Applicant submits that there are additional grounds for allowing Claim 13.

**D. Additional arguments for claims 6-8, 12, 14, which depend from claim 1**

In rejecting claim 6, the Examiner points to column 6, lines 48-57 of Dunsmore as providing the additional requirement that a performance of one or both of the test fixtures **and** a performance of one or more calibration standards of the set used in determining the port-specific difference array are unknown or poorly known. Applicant submits that the passage to which the Examiner points discusses the use of calibration standards with unknown or poorly known performance characteristics but does not teach that the performance of any test fixture is unknown or poorly known, as required by the claim. Hence, Applicant submits that there are additional grounds for allowing claim 6.

In rejecting claim 7, the Examiner points to column 7, lines 33-51 of Dunsmore as teaching the additional requirement that determining a port-specific difference array employs measurements of the test fixtures determined at a plurality of frequencies in a frequency range of interest for the DUT. Applicant submits that the passage to which the Examiner points merely refers to an operational frequency range of the DUT and states that the calibration method taught by Dunsmore "may include a broader frequency range than the frequency range of interest". Applicant submits that, at most, Dunsmore teaches that measurements of

calibration standards in a given test fixture are made at a plurality of frequencies, used to optimize models of the standards and of that test fixture, and in turn create a calibration array corresponding to that test fixture. Applicant submits that the Examiner has not pointed to any teaching regarding the making of measurements of two test fixtures at a plurality of frequencies in order to generate the terms of the difference array, as required by the Claim. Hence, Applicant submits that there are additional grounds for allowing claim 7.

In rejecting Claim 8, the Examiner points to column 12, lines 5-21 of Dunsmore as providing the additional required teaching that the set of calibration standards connects corresponding pairs of ports together so that all combinations of ports in each test fixture are separately connected as pairs for measuring the characteristics. Applicant submits that the cited passage, at most, teaches that one *thru* standard is used to connect one input portion and one output portion of one test fixture. The Examiner has not pointed to any disclosure that all combinations of ports in each test fixture are separately connected as pairs. Hence, Applicant submits that there are additional grounds for allowing claim 8.

In rejecting claim 12, the Examiner points to col. 8, lines 1-35 as providing the additional required teaching of optimizing a model using the measured results for each test fixture, the model representing one or more of the port-specific difference arrays, wherein optimizing comprises adjusting parameters of the model until a difference between test fixture measurements is minimized, the test fixture measurements being converted measurements of the second test fixture produced by the model using the measured results for the second test fixture and the measured results for the first test fixture, the model parameters representing the elements of the difference array. Applicant submits that the passage cited by the Examiner discusses computer models in a general way, offering no specific teachings regarding ports, difference arrays, optimization, or conversion between the two test fixtures. Hence, Applicant submits that there are additional grounds for allowing claim 12.

**E. Additional arguments for claims 14 and 29, which depend from claims 1 and 26 respectively**

In rejecting claims 14 and 29, the Examiner points to column 13, lines 51-62 of Dunsmore as providing the additional teaching required by these claims that solving for elements of the difference arrays comprises determining a complex square root of one of the

elements. Applicant submits that the passage in question relates to the use of the "least squares" metric, which is a mathematical technique of finding the "best fit" to a set of data by minimizing the sum of the squares of the differences between the fitted function (or model) and the data. The Claim limitation in question relates to finding a complex square root of one element in a difference array. The two mathematical operations are quite different. Hence, Applicant submits that there are additional grounds for allowing claims 14 and 29 and the Claims dependent therefrom.

### F. Rejection of claim 21 and the claims dependent therefrom

In rejecting Claim 21, the Examiner points to Column 19, lines 16-47 of Dunsmore for the required teaching that the computer program comprises instructions that, when executed by the computer, implement determining a port-specific difference array that adjusts for a difference between a first test fixture and a second test fixture when each is used to interface the DUT for measurements. First, Applicant submits that the cited passage discusses programs and models in relation to a test fixture, but does not describe the use of any type of difference array. Second, the cited passage is silent about adjusting for any **difference between two test fixtures**. Hence, Applicant submits that Dunsmore does not anticipate claim 21 and the claims dependent therefrom.

Claim 22 additionally requires that the difference array is applied to correct or adjust the measured performance of the DUT, such that the DUT performance is measured using the second test fixture that approximates a hypothetical DUT performance as if measured using the first test fixture to interface the DUT to the test equipment. The passage at Column 19, lines 16-47 cited by the Examiner discusses programs and models in relation to a test fixture, but does not teach correction or adjusting of the type required by this claim. Hence, Applicant submits that there are additional grounds for allowing claim 22 and the claims dependent therefrom.

Claim 23 additionally requires that the difference array is applied directly to the DUT measurements to transform the measured DUT performance into the hypothetical DUT performance. The Examiner points to column 7, lines 55-67 and column 8, lines 22-40 of Dunsmore for these teachings. Applicant submits that the cited passages describe model selection in a general way but are silent with respect to the specific transformation required by

the limitations of this claim. Hence, Applicant submits that there are additional grounds for allowing claim 23.

Claim 24 additionally requires that the difference array is applied to a calibration of the test equipment to correct calibration coefficients of the test equipment, such that the measured performance of the DUT is equivalent to the hypothetical DUT performance. As noted above with respect to claim 23, the passages cited by the Examiner as providing these teachings describe model selection in a general way but are silent with respect to the specific transformation required by the limitations of this claim. Hence, Applicant submits that there are additional grounds for allowing claim 24.

Claim 25 additionally requires that the computer program comprises instructions that implement determining a complex square root of an element of the difference array using values of the element at a plurality of frequencies. The Examiner points to Column 13, lines 51-62 of Dunsmore as providing this teaching. As noted above with respect to claim 14, Applicant submits that the passage in question relates to the use of the "least squares" metric, which is a mathematical technique of finding the "best fit" to a set of data by minimizing the sum of the squares of the differences between the fitted function (or model) and the data. The claim limitation in question relates to finding a complex square root of one element in a difference array. The two mathematical operations are quite different. Hence, Applicant submits that there are additional grounds for allowing claim 25.

## VIII. CONCLUSION

Appellants respectfully submit that for the reasons of fact and law argued herein, the decision of the Examiner in finally rejecting Claims 1-14 and 21-31 should be reversed.

Respectfully Submitted,

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## APPENDIX

**THE CLAIMS ON APPEAL:**

1. A method of transforming measurements of a device under test (DUT) produced by a test system, the method comprising:

   determining a port-specific difference array, the difference array describing a difference between a first test fixture and a second test fixture at a corresponding test port of the test fixtures;

   measuring a performance of the DUT using the test system, wherein the DUT is mounted in the second test fixture; and

   applying the port-specific difference array, such that the measured DUT performance approximates a hypothetical DUT performance for the DUT mounted in the first test fixture and measured with the test system.

2. The method of transforming measurements of Claim 1, wherein the determined port-specific difference array is an error adaptor that is applied to the measured performance of the DUT to essentially remove an effect of a port portion of the second test fixture and to add an effect of a corresponding port portion of the first test fixture on the measured performance.

3. The method of transforming measurements of Claim 1, wherein determining a port-specific difference array comprises:

   measuring characteristics of a set of calibration standards at corresponding ports of the first test fixture and the second test fixture by separately inserting each calibration standards of the set in each test fixture at a respective port; and

solving for elements of the difference array using results obtained from measuring characteristics of the calibration standard set for each test fixture.

4. The method of transforming measurements of Claim 1, wherein applying the difference array to the measured performance of the DUT directly transforms the measured DUT performance into the approximation of the hypothetical performance.

5. The method of transforming measurements of Claim 1, wherein applying the difference array modifies a calibration of a test system, such that the measured performance of the DUT produced using the test system is the hypothetical measured performance.

6. The method of transforming measurements of Claim 1, wherein a performance of one or both of the first test fixture and the second test fixture and a performance of one or more calibration standards of the set used in determining the port-specific difference array are unknown or poorly known.

7. The method of transforming measurements of Claim 1, wherein determining employs measurements of the test fixtures at a plurality of frequencies in a frequency range of interest for the DUT.

8.The method of transforming measurements of Claim 3, wherein the calibration standards of the set connect corresponding pairs of ports to one another for each test fixture, such that all combinations of ports in each test fixture are separately connected as pairs for measuring the characteristics.

9. The method of transforming measurements of Claim 3, wherein measuring comprises:

measuring a reflection parameter of each standard of the set of calibration standards separately for each port of the first test fixture; and

measuring a reflection parameter of each standard of the set of calibration standards separately for each corresponding port of the second test fixture.

wherein one or more of the standards of the set isolate the respective port from other ports of the respective test fixture.

10. The method of transforming measurements of Claim 3, wherein measuring comprises:

measuring S-parameters for each standard of the set of calibration standards separately for each port pair of the first test fixture; and

measuring S-parameters for each standard of the set of calibration standards separately for each port pair of the second test fixture;

wherein the standards of the set are thru standards that connect pairs of ports together to form the port pairs.

11. The method of transforming measurements of Claim 3, wherein solving for elements comprises:

solving several equations for several unknowns using the measured results, the solved unknowns representing the difference array elements.

12. The method of transforming measurements of Claim 3, wherein solving for elements comprises:

optimizing a model using the measured results for each test fixture, the model representing one or more of the port-specific difference arrays, wherein optimizing comprises adjusting parameters of the model until a difference between test fixture measurements is minimized, the test fixture measurements being converted measurements of the second test fixture produced by the model using the measured results for the second test fixture and the measured results for the first test fixture, the model parameters representing the elements of the difference array.

13. The method of transforming measurements of Claim 3, wherein measuring and solving are repeated for each port or each pair of ports of each of the test fixtures.

14. The method of transforming measurements of Claim 3, wherein solving for elements of the difference arrays comprises determining a complex square root of one of the elements, wherein the square root is determined using data representing the element at more than one frequency.

21. A test system that measures a device under test (DUT) using different test fixtures comprising:

test equipment

a test fixture that interfaces the DUT to the test equipment;

a computer connected to receive and process data from the test equipment; and

a computer program executed by the computer, the computer program comprising instructions that, when executed by the computer, implement determining a port-specific difference array that adjusts for a difference between a first test fixture and a second test fixture when each is used to interface the DUT for measurements.

22. The test system of Claim 21, wherein the computer program further comprises instructions that implement measuring a performance of the DUT when the DUT is connected to the test equipment using the second test fixture; and instructions that implement applying the difference array to correct or adjust the measured performance of the DUT, such that the DUT performance measured using the second test fixture approximates a hypothetical DUT performance as if measured using the first test fixture to interface the DUT to the test equipment.

23. The test system of Claim 22, wherein the instructions that implement applying comprise applying the difference array directly to the measured performance of the DUT

produced by the test system to transform the measured DUT performance into the hypothetical DUT performance.

24. The test system of Claim 22, wherein the instructions that implement applying comprise applying the difference array to a calibration of the test equipment to correct calibration coefficients of the test equipment, such that the measured performance of the DUT is equivalent to the hypothetical DUT performance.

25. The test system of Claim 21, wherein the computer program further comprises instructions that implement determining a complex square root of an element of the difference array using values of the element at a plurality of frequencies.

26. A method of matching measurements of a device under test (DUT) in a second test fixture to hypothetical measurements of the DUT in a first test fixture using a test system, the method comprising:

determining a port-specific difference array, the difference array describing a difference between the first test fixture and the second test fixture at a corresponding test port of the test fixtures, wherein an element of the difference arrays is determined using measurements of a set of calibration standards in the test fixtures, the measurements being performed at a plurality of frequencies with the test system.

27. The method of matching measurements of Claim 26, further comprising:

measuring a performance of the DUT using the test system, wherein the DUT is mounted in the second test fixture; and

applying the port-specific difference array to measurements of the DUT mounted in the second test fixture to transform the measurements into measurements that match the hypothetical measurements of the DUT in the first test fixture.

28. The method of matching measurements of Claim 26, wherein the element is determined by optimizing a model across the plurality of frequencies using the calibration standard measurements.

29. The method of matching measurements of Claim 26, wherein the element is determined from a complex square root of a term of a port-specific error adaptor determined from the calibration standard measurements, the complex square root being computed using a plurality of values of the error adaptor term that corresponds to the plurality of frequencies.

30. The method of matching measurements of Claim 29, wherein computing the complex square root comprises:

unwrapping a phase portion of data points representing the element at different frequencies to produce phase-unwrapped data points;

dividing a wrap-normalized phase of the data points by two to yield a phase portion of the square root; and

computing a positive real-valued square root of magnitudes of the data points to produce a magnitude portion of the square root.

31. The method of matching measurements of Claim 30, further comprising before dividing a wrap-normalized phase:

estimating a group delay of the phase-unwrapped data points;

removing from the phase portion of the phase-unwrapped data points a number of complete phase wraps associated with a first data point to produce data points having the wrap-normalized phase, the number of complete phase wraps being computed using the estimated group delay.

**Evidence Appendix**

**none**

**Related Proceedings Appendix**

**none**

**PATENT APPLICATION**
Attorney Docket: 10030978-3

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**
**BEFORE THE BOARD OF APPEALS**

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| Applicant: | Dunsmore, et al |
| Serial No.: | 10/537,031 |
| Filed: | 5/31/2005 |
| For: | Correcting Test System Calibration and Transforming Device Measurements When Using Multiple Test Fixtures |
| Group Art Unit: | 2138 |
| Examiner: | Merant, Guerrier |

**BRIEF FOR APPELLANT**

Commissioner For Patents
P.O. Box 1450
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Sir:

This is an appeal from the decision of the Primary Examiner dated 7/27/2007, finally rejecting Claims 1-14 and 21-31 in the above-identified patent application.

## I. REAL PARTY IN INTEREST

The real party in interest is Agilent Technologies, Inc. having an address as shown below.

## II. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to appellant, the appellant's legal representative, or assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in this pending appeal.

## III. STATUS OF THE CLAIMS

Claims 1-32 are currently pending in the above-identified patent application. In the Office Action dated 7/27/2007, the Examiner rejected Claims 1-14 and 21-31 and indicated that the Action was final. Claims 15-20 and 32 have been allowed.

## IV. STATUS OF AMENDMENTS

No amendments have been filed since the final Office Action dated 7/27/2007.

## V. SUMMARY OF THE CLAIMED SUBJECT MATTER

This invention addresses situations in which the performance of a device under test (DUT) is measured with the DUT interfaced to a test system by one test fixture, but it is desirable to determine what the DUT performance would have been if a second test fixture were able to be used instead. One fixture may, for example, be a relatively expensive laboratory instrument while the other fixture may be some relatively inexpensive and compact fixture used on a manufacturing production line.

In the real world, each of the test fixtures introduces errors into the measurements performed on the DUT. Various prior art schemes to correct for the errors made by a test fixture have been put forward; however, these modeling schemes typically do not provide complete correction for the errors over the full range of operating parameters that are being tested. The present invention avoids this problem by relating the measurements made with one imperfect test fixture to those made by a second imperfect test fixture so that the measurements can be compared with one another. The present invention does not require a detailed knowledge of the underlying mechanisms that give rise to the errors.

There are two independent method claims of concern in this appeal, claims 1 and 26, and one independent system claim, claim 21. With respect to claim 1, refer to Figure 1 and the discussion thereof that begins on page 8, line 3 of the specification. The claimed invention is a method of transforming measurements, beginning at step 110 with determining a port-specific difference array, whose elements are obtained by measuring the performance of a set of devices – typically a set of calibration standards - when connected in turn to one specific port, say port A1, of a first test fixture and to one specific port, say port B1, of a second test fixture. At step 120, the performance of the DUT is measured using the same port, B1, of the second (or production) test fixture. At step 130, the port-specific difference array is applied in

a way that results in the measurements made at step 120 approximating those that could hypothetically have been made if the DUT had been connected to port A1 of the other test fixture. Step 120 may be repeated for other possible pairings of ports between first and second test fixtures, resulting in multiple port-specific difference arrays that may then be used in step 130.

Claim 2 specifies that the port-specific difference array determined in step 110 is an error adaptor that is applied to the measured performance of the DUT to essentially remove an effect of a port portion of the second test fixture and to add an effect of a corresponding port portion of the first test fixture on the measured performance. Figure 2 and the associated text beginning at line 12 on page 14 of the specification shows the effect of port portions 211, 213 and 213 of the test fixture 210 on measurements of the DUT 220.

Claim 3 can best be understood by referring to Figure 4. The claim requires that the port-specific difference array is determined by measuring characteristics of a set of calibration standards at corresponding ports of the first test fixture (at 112a) and the second test fixture (at112b) by separately inserting each calibration standards of the set in each test fixture at a respective port; and solving for elements of the difference array (at 114b) using results obtained from measuring characteristics of the calibration standard set for each test fixture. Claims 8-14 depend from claim 3.

Claim 8 additionally requires that the calibration standards used in step 112 connect corresponding pairs of ports to one another for each test fixture, such that all combinations of ports in each test fixture are separately connected as pairs for measuring the characteristics. This case is illustrated in Figure 5. The additional requirement of claim 9 is that the measuring step 112 comprises measuring a reflection parameter of each standard of the set of calibration standards separately for each port of the first test fixture, and measuring a reflection parameter of each standard of the set of calibration standards separately for each corresponding port of the second test fixture, wherein one or more of the standards of the set isolate the respective port from other ports of the respective test fixture. Claim 10 specifies that the measuring step 112 comprises measuring S-parameters for each standard of the set of calibration standards separately for each port pair of the first test fixture; and measuring S-parameters for each standard of the set of calibration standards separately for each port pair of

the second test fixture; wherein the standards of the set are thru standards that connect pairs of ports together to form the port pairs. Figure 6A shows an example of part of the setup for this, with thru standard 301 connecting ports Port-1 and Port-2 of test fixture 300.

Claim 11 adds further details of step 114 of Figure 4, specifying that the solving comprises solving several equations for several unknowns using the measured results, the solved unknowns representing the difference array elements. Claim 12 adds different details to step 114 of Figure 4, specifying that the solving comprises optimizing a model using the measured results for each test fixture, the model representing one or more of the port-specific difference arrays, wherein optimizing comprises adjusting parameters of the model until a difference between test fixture measurements is minimized, the test fixture measurements being converted measurements of the second test fixture produced by the model using the measured results for the second test fixture and the measured results for the first test fixture, the model parameters representing the elements of the difference array. Claim 13 adds the requirement that measuring and solving steps 112 and 114 of Figure 4 are repeated for each port or each pair of ports of each of the test fixtures. Claim 14 adds the requirement that the solving step 114 comprises determining a complex square root of one of the elements, wherein the square root is determined using data representing the element at more than one frequency.

Claims 4 and 5 depend from claim 1 and give more details on step 130 of Figure 1, the application of the port-specific difference array to the measurements made at step 120. Claim 4 requires that the measured DUT performance is directly transformed into the approximation of the hypothetical performance. Claim 5 requires that a calibration of a test system is modified such that the measured performance of the DUT produced using the test system is the hypothetical measured performance. This method is shown in Figure 8. Claim 6 depends from claim 1 and further specifies that the performance of at least one of the test fixtures and one of the calibration standards involved in carrying out step 110 to determine the port-specific difference array, may be unknown or poorly known. Claim 7 depends from claim 1 and further specifies that the determining step, 110,110' in Figure 1 or 610, 610' in Figure 9, employs measurements of the test fixtures at a plurality of frequencies in a frequency range of interest for the DUT.

Claims 21-25 concern test systems for carrying out the methods described above. With respect to claim 21, refer to figure 7 and the discussion thereof that begins on page 28 at line 4 of the specification. The claimed invention is a test system 400 comprising test equipment 410, a test fixture 430 that interfaces the DUT to the test equipment, a computer 440 connected to receive and process data from the test equipment; and a computer program 450. The computer program comprises instructions concerning the determination of a port-specific difference array that adjusts for a difference between a first test fixture and a second test fixture, depending on which of the two is used to interface the DUT to the test system.

Claims 22-24 depend from claim 21 and give additional details on the instructions of computer program 450. Claim 22 specifies instructions that implement measuring a performance of the DUT when the DUT is connected to the test equipment using the second test fixture; and instructions that implement applying the difference array to correct or adjust the measured performance of the DUT, such that the DUT performance measured using the second test fixture approximates a hypothetical DUT performance as if measured using the first test fixture to interface the DUT to the test equipment. Claim 23 depends from claim 22 and further specifies that the instructions that implement applying comprise applying the difference array directly to the measured performance of the DUT produced by the test system to transform the measured DUT performance into the hypothetical DUT performance. This results in a system that substantially carries out the method of claim 4. Claim 24 depends from claim 22 and further specifies that the instructions that implement applying comprise applying the difference array to a calibration of the test equipment to correct calibration coefficients of the test equipment, such that the measured performance of the DUT is equivalent to the hypothetical DUT performance. This results in a system that substantially carries out the method of claim 5.

Claim 25 depends from claim 21 and further requires instructions that implement determining a complex square root of an element of the difference array using values of the element at a plurality of frequencies. Figure 9 shows the general determining step 610, 610' in cases where measurements are made at a plurality of frequencies.

With respect to claim 26, refer to Figure 9 and the description thereof that begins on page 30 at line 8 of the specification. Claim 26 covers steps 610 and 610' which determine a

port-specific difference array based on measurements made at a plurality of frequencies. An element of the difference array is determined by connecting a set of calibration standards via first and second test fixtures to the test system and making measurements at a plurality of frequencies.

Claim 27 additionally includes step 620 of Figure 9, specifying that the port-specific difference array is applied to transform measurements made using the second test fixture into those that could hypothetically have been made if the first test fixture had been used. Claims 28-31 depend from claim 27 and add details concerning the determination of elements of the port-specific difference array in step 610, 610' based on measurements at a plurality of frequencies. Claim 28 requires that a model is optimized across the plurality of frequencies using the calibration standard measurements. Claim 29 requires that the element is determined from a complex square root of a term of a port-specific error adaptor determined from the calibration standard measurements, the complex square root being computed using a plurality of values of the error adaptor term that corresponds to the plurality of frequencies.

Claim 30 depends from claim 29 and further specifies that computing the complex square root comprises unwrapping a phase portion of data points representing the element at different frequencies to produce phase-unwrapped data points; dividing a wrap-normalized phase of the data points by two to yield a phase portion of the square root; and computing a positive real-valued square root of magnitudes of the data points to produce a magnitude portion of the square root. Claim 31 depends from claim 30 and further specifies that before dividing a wrap-normalized phase: a group delay of the phase-unwrapped data points is estimated, and a number of complete phase wraps associated with a first data point is removed from the phase portion of the phase-unwrapped data points to produce data points having the wrap-normalized phase, the number of complete phase wraps being computed using the estimated group delay.

## VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

**The rejection of Claims 1-14 and 21-31 under 35 U.S.C. 102(e) as being anticipated by Dunsmore (US 6,643,597).**

## VII. ARGUMENT

### A. Examiner's Burden under 35 U.S.C. 102

The Examiner has the burden of showing by reference to the cited art each claim limitation in the reference. Anticipation under 35 U.S.C. 102 requires that each element of the claim in issue be found either expressly or inherently in a single prior art reference. In re King, 231 USPQ 136, 138 (Fed. Cir. 1986); Kalman v. Kimberly-Clark Corp., 218 USPQ 781, 789 (Fed. Cir. 1983). The mere fact that a certain thing may result from a given set of circumstances is not sufficient to sustain a rejection for anticipation. *Ex parte Skinner*, 2 USPQ2d 1788, 1789 (BdPatApp&Int 1986). "When the PTO asserts that there is an explicit or implicit teaching or suggestion in the prior art, it must indicate where such a teaching or suggestion appears in the reference" (*In re* Rijckaert, 28 USPQ2d, 1955, 1957).

Under the doctrine of inherency, if an element is not expressly disclosed in a prior art reference, the reference will still be deemed to anticipate a subsequent claim if the missing element "is necessarily present in the thing described in the reference" Cont'l Can Co. v. Monsanto Co., 948 F.2d 1264, 1268, 20 USPQ2d 1746, 1749(Fed. Cir. 1991). "Inherent anticipation requires that the missing descriptive material is 'necessarily present,' not merely probably or possibly present, in the prior art." Trintec Indus., Inc. v. Top-U.S.A. Corp., 295 F.3d 1292, 1295, 63 USPQ2d 1597, 1599(Fed. Cir. 2002) (quoting In re Robertson, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999)).

### B. Rejection of claims 1 and 26 and the claims dependent therefrom

Claims 1 and 26 require the determination of a port-specific difference array, the difference array describing a difference between a first test fixture and a second test fixture at a corresponding test port of the test fixtures. The Examiner points to Dunsmore (col. 13, lines 5-20; col. 14, lines 47-67 and col. 15, lines 1-13) as teaching this limitation, identifying element 140 of Figure 1 as the "the port-specific difference array that is created to record the difference between the test fixture (item 430A, Fig. 5) and a standard (item 420, Fig. 5)".

Applicant submits that the cited passages do not teach the claim limitations. Figure 1 of Dunsmore and the cited passages simply teach that element 140 is a "calibration array" that

is created using the test fixture and models for the standards after the models have been optimized by the earlier steps of calibration method 100. Applicant submits that the cited passages do not teach either that 140 is a port-specific difference array, or that the differences in question are the differences between first and second text fixtures at a corresponding test port of the test fixture.

First, regarding the requirement that the array is a difference array, Applicant submits that the teaching in Dunsmore regarding differences (for example in column 13, lines 52-67, and in claim 12) concerns the use of differences between simulation and measured values in determining the minimization metrics used to optimize the models,. These differences are used to adjust the element values in the models, and are not themselves incorporated into the models. Applicant submits that the Examiner has not pointed to any teaching that these differences appear as elements of array 140.

Second, even if calibration array 140 taught by Dunsmore were taken to represent differences of some kind, the Examiner states that the differences would be those between test fixture 430A and standard 420, but the claim requires differences between two test fixtures. Hence, the Examiner must be assigning the calibration standard 420 as the second test fixture. Dunsmore teaches in Figure 5 and the related passage (col. 18, lines 21-31) that 420 is a set of calibration standards, such as, for example, a short, an open, a load, and a thru (SOLT). Dunsmore also teaches that a test fixture is an element that provides an electrical and mechanical interface (col. 7, lines 12-26) either **between the test system and the calibration standards** (Figure 5 and col. 18, lines 58-61) or **between the test system and the DUT** (Figure 5 and col. 18, lines 32-42). Hence, the standards identified by the Examiner could not be a second test fixture, since the standards are not used to connected the DUT to the test system. Moreover, the claims require that the DUT is measured when mounted in the second test fixture. There is no teaching in Dunsmore that the DUT is even mounted in the calibration standard, or connected to it during any measurement process. In this regard, it should be noted that the calibration standard is used in place of the DUT during certain calibration operations.

Accordingly, Applicant submits that even if array 420 were to represent differences between calibration standard 420 and test fixture 430A, as suggested by the Examiner, it would not represent differences between two test fixtures, as the claims require.

Hence, Applicant submits that Dunsmore does not anticipate claims 1, 26, or the claims dependent therefrom.

**C. Additional arguments for claims 2-3, 11 and 13, which depend from claim 1**

In rejecting claims 2-3, 11, and 13, the Examiner points to column 14, lines 61-67, column 15, lines 1-13, column 18, lines 55-67, and column 19, lines 1-10 as teaching that "the determined port-specific difference array is an error adaptor that is applied to the measured performance of the DUT to essentially remove an effect of a port portion of the second test fixture and to add an effect of a corresponding port portion of the first test fixture on the measured performance". First, Applicant submits that the limitation which the Examiner discusses here is relevant only to Claim 2, not Claims 3, 11, and 13. Second, Applicant disagrees with the Examiner's reading of Dunsmore as teaching all the limitations of Claim 2.

First, as discussed above with respect to Claim 1, Dunsmore does not teach the limitation relating to determining a port-specific difference array. Second, claim 2 additionally requires that array to be applied to the DUT measurements to remove an effect of a port portion of the second test fixture and to add an effect of a corresponding port portion of the first test fixture. Applicant submits that the passages to which the Examiner points discuss models and their optimization, but do not disclose that any difference array is applied, nor that the calibration that is described therein has the effects regarding port portions of text fixtures that are required by the claim. Hence, Applicant submits that there are additional grounds for allowing claim 2.

Claim 3 requires that characteristics of a set of calibration standards are measured at corresponding ports of the two test fixtures by separately inserting each calibration standard of the set in each test fixture at a respective port; and solving for elements of the difference array using results obtained from measuring characteristics of the calibration standard set for each test fixture. Applicant submits that the passages to which the Examiner points discuss

models and their optimization, but do not disclose the measurement of calibration standards in the manner specified by this claim. Hence, Applicant submits that there are additional grounds for allowing claim 3 and the claims dependent therefrom.

Claim 11 requires that several equations are solved for several unknowns using the measured results, the solved unknowns representing the difference array elements. The passages to which the Examiner points discuss models and their optimization, but do not disclose the solving of several equations for several unknowns representing difference array elements. Hence, Applicant submits that there are additional grounds for allowing claim 11.

Claim 13 requires that the measuring and solving are repeated for each port or each pair of ports of each of the test fixtures. The passages to which the Examiner points discuss models and their optimization, but do not disclose the measuring and solving for each port or each pair of ports of each test fixture. Hence, Applicant submits that there are additional grounds for allowing Claim 13.

**D. Additional arguments for claims 6-8, 12, 14, which depend from claim 1**

In rejecting claim 6, the Examiner points to column 6, lines 48-57 of Dunsmore as providing the additional requirement that a performance of one or both of the test fixtures **and** a performance of one or more calibration standards of the set used in determining the port-specific difference array are unknown or poorly known. Applicant submits that the passage to which the Examiner points discusses the use of calibration standards with unknown or poorly known performance characteristics but does not teach that the performance of any test fixture is unknown or poorly known, as required by the claim. Hence, Applicant submits that there are additional grounds for allowing claim 6.

In rejecting claim 7, the Examiner points to column 7, lines 33-51 of Dunsmore as teaching the additional requirement that determining a port-specific difference array employs measurements of the test fixtures determined at a plurality of frequencies in a frequency range of interest for the DUT. Applicant submits that the passage to which the Examiner points merely refers to an operational frequency range of the DUT and states that the calibration method taught by Dunsmore "may include a broader frequency range than the frequency range of interest". Applicant submits that, at most, Dunsmore teaches that measurements of

calibration standards in a given test fixture are made at a plurality of frequencies, used to optimize models of the standards and of that test fixture, and in turn create a calibration array corresponding to that test fixture. Applicant submits that the Examiner has not pointed to any teaching regarding the making of measurements of two test fixtures at a plurality of frequencies in order to generate the terms of the difference array, as required by the Claim. Hence, Applicant submits that there are additional grounds for allowing claim 7.

In rejecting Claim 8, the Examiner points to column 12, lines 5-21 of Dunsmore as providing the additional required teaching that the set of calibration standards connects corresponding pairs of ports together so that all combinations of ports in each test fixture are separately connected as pairs for measuring the characteristics. Applicant submits that the cited passage, at most, teaches that one *thru* standard is used to connect one input portion and one output portion of one test fixture. The Examiner has not pointed to any disclosure that all combinations of ports in each test fixture are separately connected as pairs. Hence, Applicant submits that there are additional grounds for allowing claim 8.

In rejecting claim 12, the Examiner points to col. 8, lines 1-35 as providing the additional required teaching of optimizing a model using the measured results for each test fixture, the model representing one or more of the port-specific difference arrays, wherein optimizing comprises adjusting parameters of the model until a difference between test fixture measurements is minimized, the test fixture measurements being converted measurements of the second test fixture produced by the model using the measured results for the second test fixture and the measured results for the first test fixture, the model parameters representing the elements of the difference array. Applicant submits that the passage cited by the Examiner discusses computer models in a general way, offering no specific teachings regarding ports, difference arrays, optimization, or conversion between the two test fixtures. Hence, Applicant submits that there are additional grounds for allowing claim 12.

**E. Additional arguments for claims 14 and 29, which depend from claims 1 and 26 respectively**

In rejecting claims 14 and 29, the Examiner points to column 13, lines 51-62 of Dunsmore as providing the additional teaching required by these claims that solving for elements of the difference arrays comprises determining a complex square root of one of the

elements. Applicant submits that the passage in question relates to the use of the "least squares" metric, which is a mathematical technique of finding the "best fit" to a set of data by minimizing the sum of the squares of the differences between the fitted function (or model) and the data. The Claim limitation in question relates to finding a complex square root of one element in a difference array. The two mathematical operations are quite different. Hence, Applicant submits that there are additional grounds for allowing claims 14 and 29 and the Claims dependent therefrom.

### F. Rejection of claim 21 and the claims dependent therefrom

In rejecting Claim 21, the Examiner points to Column 19, lines 16-47 of Dunsmore for the required teaching that the computer program comprises instructions that, when executed by the computer, implement determining a port-specific difference array that adjusts for a difference between a first test fixture and a second test fixture when each is used to interface the DUT for measurements. First, Applicant submits that the cited passage discusses programs and models in relation to a test fixture, but does not describe the use of any type of difference array. Second, the cited passage is silent about adjusting for any **difference between two test fixtures**. Hence, Applicant submits that Dunsmore does not anticipate claim 21 and the claims dependent therefrom.

Claim 22 additionally requires that the difference array is applied to correct or adjust the measured performance of the DUT, such that the DUT performance is measured using the second test fixture that approximates a hypothetical DUT performance as if measured using the first test fixture to interface the DUT to the test equipment. The passage at Column 19, lines 16-47 cited by the Examiner discusses programs and models in relation to a test fixture, but does not teach correction or adjusting of the type required by this claim. Hence, Applicant submits that there are additional grounds for allowing claim 22 and the claims dependent therefrom.

Claim 23 additionally requires that the difference array is applied directly to the DUT measurements to transform the measured DUT performance into the hypothetical DUT performance. The Examiner points to column 7, lines 55-67 and column 8, lines 22-40 of Dunsmore for these teachings. Applicant submits that the cited passages describe model selection in a general way but are silent with respect to the specific transformation required by

the limitations of this claim. Hence, Applicant submits that there are additional grounds for allowing claim 23.

Claim 24 additionally requires that the difference array is applied to a calibration of the test equipment to correct calibration coefficients of the test equipment, such that the measured performance of the DUT is equivalent to the hypothetical DUT performance. As noted above with respect to claim 23, the passages cited by the Examiner as providing these teachings describe model selection in a general way but are silent with respect to the specific transformation required by the limitations of this claim. Hence, Applicant submits that there are additional grounds for allowing claim 24.

Claim 25 additionally requires that the computer program comprises instructions that implement determining a complex square root of an element of the difference array using values of the element at a plurality of frequencies. The Examiner points to Column 13, lines 51-62 of Dunsmore as providing this teaching. As noted above with respect to claim 14, Applicant submits that the passage in question relates to the use of the “least squares” metric, which is a mathematical technique of finding the “best fit” to a set of data by minimizing the sum of the squares of the differences between the fitted function (or model) and the data. The claim limitation in question relates to finding a complex square root of one element in a difference array. The two mathematical operations are quite different. Hence, Applicant submits that there are additional grounds for allowing claim 25.

## VIII. CONCLUSION

Appellants respectfully submit that for the reasons of fact and law argued herein, the decision of the Examiner in finally rejecting Claims 1-14 and 21-31 should be reversed.

Respectfully Submitted,

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## APPENDIX

**THE CLAIMS ON APPEAL:**

1. A method of transforming measurements of a device under test (DUT) produced by a test system, the method comprising:

determining a port-specific difference array, the difference array describing a difference between a first test fixture and a second test fixture at a corresponding test port of the test fixtures;

measuring a performance of the DUT using the test system, wherein the DUT is mounted in the second test fixture; and

applying the port-specific difference array, such that the measured DUT performance approximates a hypothetical DUT performance for the DUT mounted in the first test fixture and measured with the test system.

2. The method of transforming measurements of Claim 1, wherein the determined port-specific difference array is an error adaptor that is applied to the measured performance of the DUT to essentially remove an effect of a port portion of the second test fixture and to add an effect of a corresponding port portion of the first test fixture on the measured performance.

3. The method of transforming measurements of Claim 1, wherein determining a port-specific difference array comprises:

measuring characteristics of a set of calibration standards at corresponding ports of the first test fixture and the second test fixture by separately inserting each calibration standards of the set in each test fixture at a respective port; and

solving for elements of the difference array using results obtained from measuring characteristics of the calibration standard set for each test fixture.

4. The method of transforming measurements of Claim 1, wherein applying the difference array to the measured performance of the DUT directly transforms the measured DUT performance into the approximation of the hypothetical performance.

5. The method of transforming measurements of Claim 1, wherein applying the difference array modifies a calibration of a test system, such that the measured performance of the DUT produced using the test system is the hypothetical measured performance.

6. The method of transforming measurements of Claim 1, wherein a performance of one or both of the first test fixture and the second test fixture and a performance of one or more calibration standards of the set used in determining the port-specific difference array are unknown or poorly known.

7. The method of transforming measurements of Claim 1, wherein determining employs measurements of the test fixtures at a plurality of frequencies in a frequency range of interest for the DUT.

8.The method of transforming measurements of Claim 3, wherein the calibration standards of the set connect corresponding pairs of ports to one another for each test fixture, such that all combinations of ports in each test fixture are separately connected as pairs for measuring the characteristics.

9. The method of transforming measurements of Claim 3, wherein measuring comprises:

measuring a reflection parameter of each standard of the set of calibration standards separately for each port of the first test fixture; and

measuring a reflection parameter of each standard of the set of calibration standards separately for each corresponding port of the second test fixture.

wherein one or more of the standards of the set isolate the respective port from other ports of the respective test fixture.

10. The method of transforming measurements of Claim 3, wherein measuring comprises:

measuring S-parameters for each standard of the set of calibration standards separately for each port pair of the first test fixture; and

measuring S-parameters for each standard of the set of calibration standards separately for each port pair of the second test fixture;

wherein the standards of the set are thru standards that connect pairs of ports together to form the port pairs.

11. The method of transforming measurements of Claim 3, wherein solving for elements comprises:

solving several equations for several unknowns using the measured results, the solved unknowns representing the difference array elements.

12. The method of transforming measurements of Claim 3, wherein solving for elements comprises:

optimizing a model using the measured results for each test fixture, the model representing one or more of the port-specific difference arrays, wherein optimizing comprises adjusting parameters of the model until a difference between test fixture measurements is minimized, the test fixture measurements being converted measurements of the second test fixture produced by the model using the measured results for the second test fixture and the measured results for the first test fixture, the model parameters representing the elements of the difference array.

13. The method of transforming measurements of Claim 3, wherein measuring and solving are repeated for each port or each pair of ports of each of the test fixtures.

14. The method of transforming measurements of Claim 3, wherein solving for elements of the difference arrays comprises determining a complex square root of one of the elements, wherein the square root is determined using data representing the element at more than one frequency.

21. A test system that measures a device under test (DUT) using different test fixtures comprising:

test equipment

a test fixture that interfaces the DUT to the test equipment;

a computer connected to receive and process data from the test equipment; and

a computer program executed by the computer, the computer program comprising instructions that, when executed by the computer, implement determining a port-specific difference array that adjusts for a difference between a first test fixture and a second test fixture when each is used to interface the DUT for measurements.

22. The test system of Claim 21, wherein the computer program further comprises instructions that implement measuring a performance of the DUT when the DUT is connected to the test equipment using the second test fixture; and instructions that implement applying the difference array to correct or adjust the measured performance of the DUT, such that the DUT performance measured using the second test fixture approximates a hypothetical DUT performance as if measured using the first test fixture to interface the DUT to the test equipment.

23. The test system of Claim 22, wherein the instructions that implement applying comprise applying the difference array directly to the measured performance of the DUT

produced by the test system to transform the measured DUT performance into the hypothetical DUT performance.

24. The test system of Claim 22, wherein the instructions that implement applying comprise applying the difference array to a calibration of the test equipment to correct calibration coefficients of the test equipment, such that the measured performance of the DUT is equivalent to the hypothetical DUT performance.

25. The test system of Claim 21, wherein the computer program further comprises instructions that implement determining a complex square root of an element of the difference array using values of the element at a plurality of frequencies.

26. A method of matching measurements of a device under test (DUT) in a second test fixture to hypothetical measurements of the DUT in a first test fixture using a test system, the method comprising:

determining a port-specific difference array, the difference array describing a difference between the first test fixture and the second test fixture at a corresponding test port of the test fixtures, wherein an element of the difference arrays is determined using measurements of a set of calibration standards in the test fixtures, the measurements being performed at a plurality of frequencies with the test system.

27. The method of matching measurements of Claim 26, further comprising:

measuring a performance of the DUT using the test system, wherein the DUT is mounted in the second test fixture; and

applying the port-specific difference array to measurements of the DUT mounted in the second test fixture to transform the measurements into measurements that match the hypothetical measurements of the DUT in the first test fixture.

28. The method of matching measurements of Claim 26, wherein the element is determined by optimizing a model across the plurality of frequencies using the calibration standard measurements.

29. The method of matching measurements of Claim 26, wherein the element is determined from a complex square root of a term of a port-specific error adaptor determined from the calibration standard measurements, the complex square root being computed using a plurality of values of the error adaptor term that corresponds to the plurality of frequencies.

30. The method of matching measurements of Claim 29, wherein computing the complex square root comprises:

unwrapping a phase portion of data points representing the element at different frequencies to produce phase-unwrapped data points;

dividing a wrap-normalized phase of the data points by two to yield a phase portion of the square root; and

computing a positive real-valued square root of magnitudes of the data points to produce a magnitude portion of the square root.

31. The method of matching measurements of Claim 30, further comprising before dividing a wrap-normalized phase:

estimating a group delay of the phase-unwrapped data points;

removing from the phase portion of the phase-unwrapped data points a number of complete phase wraps associated with a first data point to produce data points having the wrap-normalized phase, the number of complete phase wraps being computed using the estimated group delay.

**Evidence Appendix**

**none**

**Related Proceedings Appendix**

**none**

**PATENT APPLICATION**
Attorney Docket: 10030978-3

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**
**BEFORE THE BOARD OF APPEALS**

| | |
|---|---|
| Applicant: | Dunsmore, et al |
| Serial No.: | 10/537,031 |
| Filed: | 5/31/2005 |
| For: | Correcting Test System Calibration and Transforming Device Measurements When Using Multiple Test Fixtures |
| Group Art Unit: | 2138 |
| Examiner: | Merant, Guerrier |

**BRIEF FOR APPELLANT**

Commissioner For Patents
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Sir:

This is an appeal from the decision of the Primary Examiner dated 7/27/2007, finally rejecting Claims 1-14 and 21-31 in the above-identified patent application.

## I. REAL PARTY IN INTEREST

The real party in interest is Agilent Technologies, Inc. having an address as shown below.

## II. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to appellant, the appellant's legal representative, or assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in this pending appeal.

## III. STATUS OF THE CLAIMS

Claims 1-32 are currently pending in the above-identified patent application. In the Office Action dated 7/27/2007, the Examiner rejected Claims 1-14 and 21-31 and indicated that the Action was final. Claims 15-20 and 32 have been allowed.

## IV. STATUS OF AMENDMENTS

No amendments have been filed since the final Office Action dated 7/27/2007.

## V. SUMMARY OF THE CLAIMED SUBJECT MATTER

This invention addresses situations in which the performance of a device under test (DUT) is measured with the DUT interfaced to a test system by one test fixture, but it is desirable to determine what the DUT performance would have been if a second test fixture were able to be used instead. One fixture may, for example, be a relatively expensive laboratory instrument while the other fixture may be some relatively inexpensive and compact fixture used on a manufacturing production line.

In the real world, each of the test fixtures introduces errors into the measurements performed on the DUT. Various prior art schemes to correct for the errors made by a test fixture have been put forward; however, these modeling schemes typically do not provide complete correction for the errors over the full range of operating parameters that are being tested. The present invention avoids this problem by relating the measurements made with one imperfect test fixture to those made by a second imperfect test fixture so that the measurements can be compared with one another. The present invention does not require a detailed knowledge of the underlying mechanisms that give rise to the errors.

There are two independent method claims of concern in this appeal, claims 1 and 26, and one independent system claim, claim 21. With respect to claim 1, refer to Figure 1 and the discussion thereof that begins on page 8, line 3 of the specification. The claimed invention is a method of transforming measurements, beginning at step 110 with determining a port-specific difference array, whose elements are obtained by measuring the performance of a set of devices – typically a set of calibration standards - when connected in turn to one specific port, say port A1, of a first test fixture and to one specific port, say port B1, of a second test fixture. At step 120, the performance of the DUT is measured using the same port, B1, of the second (or production) test fixture. At step 130, the port-specific difference array is applied in

a way that results in the measurements made at step 120 approximating those that could hypothetically have been made if the DUT had been connected to port A1 of the other test fixture. Step 120 may be repeated for other possible pairings of ports between first and second test fixtures, resulting in multiple port-specific difference arrays that may then be used in step 130.

Claim 2 specifies that the port-specific difference array determined in step 110 is an error adaptor that is applied to the measured performance of the DUT to essentially remove an effect of a port portion of the second test fixture and to add an effect of a corresponding port portion of the first test fixture on the measured performance. Figure 2 and the associated text beginning at line 12 on page 14 of the specification shows the effect of port portions 211, 213 and 213 of the test fixture 210 on measurements of the DUT 220.

Claim 3 can best be understood by referring to Figure 4. The claim requires that the port-specific difference array is determined by measuring characteristics of a set of calibration standards at corresponding ports of the first test fixture (at 112a) and the second test fixture (at112b) by separately inserting each calibration standards of the set in each test fixture at a respective port; and solving for elements of the difference array (at 114b) using results obtained from measuring characteristics of the calibration standard set for each test fixture. Claims 8-14 depend from claim 3.

Claim 8 additionally requires that the calibration standards used in step 112 connect corresponding pairs of ports to one another for each test fixture, such that all combinations of ports in each test fixture are separately connected as pairs for measuring the characteristics. This case is illustrated in Figure 5. The additional requirement of claim 9 is that the measuring step 112 comprises measuring a reflection parameter of each standard of the set of calibration standards separately for each port of the first test fixture, and measuring a reflection parameter of each standard of the set of calibration standards separately for each corresponding port of the second test fixture, wherein one or more of the standards of the set isolate the respective port from other ports of the respective test fixture. Claim 10 specifies that the measuring step 112 comprises measuring S-parameters for each standard of the set of calibration standards separately for each port pair of the first test fixture; and measuring S-parameters for each standard of the set of calibration standards separately for each port pair of

the second test fixture; wherein the standards of the set are thru standards that connect pairs of ports together to form the port pairs. Figure 6A shows an example of part of the setup for this, with thru standard 301 connecting ports Port-1 and Port-2 of test fixture 300.

Claim 11 adds further details of step 114 of Figure 4, specifying that the solving comprises solving several equations for several unknowns using the measured results, the solved unknowns representing the difference array elements. Claim 12 adds different details to step 114 of Figure 4, specifying that the solving comprises optimizing a model using the measured results for each test fixture, the model representing one or more of the port-specific difference arrays, wherein optimizing comprises adjusting parameters of the model until a difference between test fixture measurements is minimized, the test fixture measurements being converted measurements of the second test fixture produced by the model using the measured results for the second test fixture and the measured results for the first test fixture, the model parameters representing the elements of the difference array. Claim 13 adds the requirement that measuring and solving steps 112 and 114 of Figure 4 are repeated for each port or each pair of ports of each of the test fixtures. Claim 14 adds the requirement that the solving step 114 comprises determining a complex square root of one of the elements, wherein the square root is determined using data representing the element at more than one frequency.

Claims 4 and 5 depend from claim 1 and give more details on step 130 of Figure 1, the application of the port-specific difference array to the measurements made at step 120. Claim 4 requires that the measured DUT performance is directly transformed into the approximation of the hypothetical performance. Claim 5 requires that a calibration of a test system is modified such that the measured performance of the DUT produced using the test system is the hypothetical measured performance. This method is shown in Figure 8. Claim 6 depends from claim 1 and further specifies that the performance of at least one of the test fixtures and one of the calibration standards involved in carrying out step 110 to determine the port-specific difference array, may be unknown or poorly known. Claim 7 depends from claim 1 and further specifies that the determining step, 110,110’ in Figure 1 or 610, 610’ in Figure 9, employs measurements of the test fixtures at a plurality of frequencies in a frequency range of interest for the DUT.

Claims 21-25 concern test systems for carrying out the methods described above. With respect to claim 21, refer to figure 7 and the discussion thereof that begins on page 28 at line 4 of the specification. The claimed invention is a test system 400 comprising test equipment 410, a test fixture 430 that interfaces the DUT to the test equipment, a computer 440 connected to receive and process data from the test equipment; and a computer program 450. The computer program comprises instructions concerning the determination of a port-specific difference array that adjusts for a difference between a first test fixture and a second test fixture, depending on which of the two is used to interface the DUT to the test system.

Claims 22-24 depend from claim 21 and give additional details on the instructions of computer program 450. Claim 22 specifies instructions that implement measuring a performance of the DUT when the DUT is connected to the test equipment using the second test fixture; and instructions that implement applying the difference array to correct or adjust the measured performance of the DUT, such that the DUT performance measured using the second test fixture approximates a hypothetical DUT performance as if measured using the first test fixture to interface the DUT to the test equipment. Claim 23 depends from claim 22 and further specifies that the instructions that implement applying comprise applying the difference array directly to the measured performance of the DUT produced by the test system to transform the measured DUT performance into the hypothetical DUT performance. This results in a system that substantially carries out the method of claim 4. Claim 24 depends from claim 22 and further specifies that the instructions that implement applying comprise applying the difference array to a calibration of the test equipment to correct calibration coefficients of the test equipment, such that the measured performance of the DUT is equivalent to the hypothetical DUT performance. This results in a system that substantially carries out the method of claim 5.

Claim 25 depends from claim 21 and further requires instructions that implement determining a complex square root of an element of the difference array using values of the element at a plurality of frequencies. Figure 9 shows the general determining step 610, 610' in cases where measurements are made at a plurality of frequencies.

With respect to claim 26, refer to Figure 9 and the description thereof that begins on page 30 at line 8 of the specification. Claim 26 covers steps 610 and 610' which determine a

port-specific difference array based on measurements made at a plurality of frequencies. An element of the difference array is determined by connecting a set of calibration standards via first and second test fixtures to the test system and making measurements at a plurality of frequencies.

Claim 27 additionally includes step 620 of Figure 9, specifying that the port-specific difference array is applied to transform measurements made using the second test fixture into those that could hypothetically have been made if the first test fixture had been used. Claims 28-31 depend from claim 27 and add details concerning the determination of elements of the port-specific difference array in step 610, 610' based on measurements at a plurality of frequencies. Claim 28 requires that a model is optimized across the plurality of frequencies using the calibration standard measurements. Claim 29 requires that the element is determined from a complex square root of a term of a port-specific error adaptor determined from the calibration standard measurements, the complex square root being computed using a plurality of values of the error adaptor term that corresponds to the plurality of frequencies.

Claim 30 depends from claim 29 and further specifies that computing the complex square root comprises unwrapping a phase portion of data points representing the element at different frequencies to produce phase-unwrapped data points; dividing a wrap-normalized phase of the data points by two to yield a phase portion of the square root; and computing a positive real-valued square root of magnitudes of the data points to produce a magnitude portion of the square root. Claim 31 depends from claim 30 and further specifies that before dividing a wrap-normalized phase: a group delay of the phase-unwrapped data points is estimated, and a number of complete phase wraps associated with a first data point is removed from the phase portion of the phase-unwrapped data points to produce data points having the wrap-normalized phase, the number of complete phase wraps being computed using the estimated group delay.

## VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

**The rejection of Claims 1-14 and 21-31 under 35 U.S.C. 102(e) as being anticipated by Dunsmore (US 6,643,597).**

## VII. ARGUMENT

### <u>A. Examiner's Burden under 35 U.S.C. 102</u>

The Examiner has the burden of showing by reference to the cited art each claim limitation in the reference. Anticipation under 35 U.S.C. 102 requires that each element of the claim in issue be found either expressly or inherently in a single prior art reference. In re King, 231 USPQ 136, 138 (Fed. Cir. 1986); Kalman v. Kimberly-Clark Corp., 218 USPQ 781, 789 (Fed. Cir. 1983). The mere fact that a certain thing may result from a given set of circumstances is not sufficient to sustain a rejection for anticipation. *Ex parte Skinner*, 2 USPQ2d 1788, 1789 (BdPatApp&Int 1986). "When the PTO asserts that there is an explicit or implicit teaching or suggestion in the prior art, it must indicate where such a teaching or suggestion appears in the reference" (*In re* Rijckaert, 28 USPQ2d, 1955, 1957).

Under the doctrine of inherency, if an element is not expressly disclosed in a prior art reference, the reference will still be deemed to anticipate a subsequent claim if the missing element "is necessarily present in the thing described in the reference" Cont'l Can Co. v. Monsanto Co., 948 F.2d 1264, 1268, 20 USPQ2d 1746, 1749(Fed. Cir. 1991). "Inherent anticipation requires that the missing descriptive material is 'necessarily present,' not merely probably or possibly present, in the prior art." Trintec Indus., Inc. v. Top-U.S.A. Corp., 295 F.3d 1292, 1295, 63 USPQ2d 1597, 1599(Fed. Cir. 2002) (quoting In re Robertson, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999)).

### <u>B. Rejection of claims 1 and 26 and the claims dependent therefrom</u>

Claims 1 and 26 require the determination of a port-specific difference array, the difference array describing a difference between a first test fixture and a second test fixture at a corresponding test port of the test fixtures. The Examiner points to Dunsmore (col. 13, lines 5-20; col. 14, lines 47-67 and col. 15, lines 1-13) as teaching this limitation, identifying element 140 of Figure 1 as the "the port-specific difference array that is created to record the difference between the test fixture (item 430A, Fig. 5) and a standard (item 420, Fig. 5)".

Applicant submits that the cited passages do not teach the claim limitations. Figure 1 of Dunsmore and the cited passages simply teach that element 140 is a "calibration array" that

is created using the test fixture and models for the standards after the models have been optimized by the earlier steps of calibration method 100. Applicant submits that the cited passages do not teach either that 140 is a port-specific difference array, or that the differences in question are the differences between first and second text fixtures at a corresponding test port of the test fixture.

First, regarding the requirement that the array is a difference array, Applicant submits that the teaching in Dunsmore regarding differences (for example in column 13, lines 52-67, and in claim 12) concerns the use of differences between simulation and measured values in determining the minimization metrics used to optimize the models,. These differences are used to adjust the element values in the models, and are not themselves incorporated into the models. Applicant submits that the Examiner has not pointed to any teaching that these differences appear as elements of array 140.

Second, even if calibration array 140 taught by Dunsmore were taken to represent differences of some kind, the Examiner states that the differences would be those between test fixture 430A and standard 420, but the claim requires differences between two test fixtures. Hence, the Examiner must be assigning the calibration standard 420 as the second test fixture. Dunsmore teaches in Figure 5 and the related passage (col. 18, lines 21-31) that 420 is a set of calibration standards, such as, for example, a short, an open, a load, and a thru (SOLT). Dunsmore also teaches that a test fixture is an element that provides an electrical and mechanical interface (col. 7, lines 12-26) either **between the test system and the calibration standards** (Figure 5 and col. 18, lines 58-61) or **between the test system and the DUT** (Figure 5 and col. 18, lines 32-42). Hence, the standards identified by the Examiner could not be a second test fixture, since the standards are not used to connected the DUT to the test system. Moreover, the claims require that the DUT is measured when mounted in the second test fixture. There is no teaching in Dunsmore that the DUT is even mounted in the calibration standard, or connected to it during any measurement process. In this regard, it should be noted that the calibration standard is used in place of the DUT during certain calibration operations.

Accordingly, Applicant submits that even if array 420 were to represent differences between calibration standard 420 and test fixture 430A, as suggested by the Examiner, it would not represent differences between two test fixtures, as the claims require.

Hence, Applicant submits that Dunsmore does not anticipate claims 1, 26, or the claims dependent therefrom.

**C. Additional arguments for claims 2-3, 11 and 13, which depend from claim 1**

In rejecting claims 2-3, 11, and 13, the Examiner points to column 14, lines 61-67, column 15, lines 1-13, column 18, lines 55-67, and column 19, lines 1-10 as teaching that "the determined port-specific difference array is an error adaptor that is applied to the measured performance of the DUT to essentially remove an effect of a port portion of the second test fixture and to add an effect of a corresponding port portion of the first test fixture on the measured performance". First, Applicant submits that the limitation which the Examiner discusses here is relevant only to Claim 2, not Claims 3, 11, and 13. Second, Applicant disagrees with the Examiner's reading of Dunsmore as teaching all the limitations of Claim 2.

First, as discussed above with respect to Claim 1, Dunsmore does not teach the limitation relating to determining a port-specific difference array. Second, claim 2 additionally requires that array to be applied to the DUT measurements to remove an effect of a port portion of the second test fixture and to add an effect of a corresponding port portion of the first test fixture. Applicant submits that the passages to which the Examiner points discuss models and their optimization, but do not disclose that any difference array is applied, nor that the calibration that is described therein has the effects regarding port portions of text fixtures that are required by the claim. Hence, Applicant submits that there are additional grounds for allowing claim 2.

Claim 3 requires that characteristics of a set of calibration standards are measured at corresponding ports of the two test fixtures by separately inserting each calibration standard of the set in each test fixture at a respective port; and solving for elements of the difference array using results obtained from measuring characteristics of the calibration standard set for each test fixture. Applicant submits that the passages to which the Examiner points discuss

models and their optimization, but do not disclose the measurement of calibration standards in the manner specified by this claim. Hence, Applicant submits that there are additional grounds for allowing claim 3 and the claims dependent therefrom.

Claim 11 requires that several equations are solved for several unknowns using the measured results, the solved unknowns representing the difference array elements. The passages to which the Examiner points discuss models and their optimization, but do not disclose the solving of several equations for several unknowns representing difference array elements. Hence, Applicant submits that there are additional grounds for allowing claim 11.

Claim 13 requires that the measuring and solving are repeated for each port or each pair of ports of each of the test fixtures. The passages to which the Examiner points discuss models and their optimization, but do not disclose the measuring and solving for each port or each pair of ports of each test fixture. Hence, Applicant submits that there are additional grounds for allowing Claim 13.

**D. Additional arguments for claims 6-8, 12, 14, which depend from claim 1**

In rejecting claim 6, the Examiner points to column 6, lines 48-57 of Dunsmore as providing the additional requirement that a performance of one or both of the test fixtures **and** a performance of one or more calibration standards of the set used in determining the port-specific difference array are unknown or poorly known. Applicant submits that the passage to which the Examiner points discusses the use of calibration standards with unknown or poorly known performance characteristics but does not teach that the performance of any test fixture is unknown or poorly known, as required by the claim. Hence, Applicant submits that there are additional grounds for allowing claim 6.

In rejecting claim 7, the Examiner points to column 7, lines 33-51 of Dunsmore as teaching the additional requirement that determining a port-specific difference array employs measurements of the test fixtures determined at a plurality of frequencies in a frequency range of interest for the DUT. Applicant submits that the passage to which the Examiner points merely refers to an operational frequency range of the DUT and states that the calibration method taught by Dunsmore "may include a broader frequency range than the frequency range of interest". Applicant submits that, at most, Dunsmore teaches that measurements of

calibration standards in a given test fixture are made at a plurality of frequencies, used to optimize models of the standards and of that test fixture, and in turn create a calibration array corresponding to that test fixture. Applicant submits that the Examiner has not pointed to any teaching regarding the making of measurements of two test fixtures at a plurality of frequencies in order to generate the terms of the difference array, as required by the Claim. Hence, Applicant submits that there are additional grounds for allowing claim 7.

In rejecting Claim 8, the Examiner points to column 12, lines 5-21 of Dunsmore as providing the additional required teaching that the set of calibration standards connects corresponding pairs of ports together so that all combinations of ports in each test fixture are separately connected as pairs for measuring the characteristics. Applicant submits that the cited passage, at most, teaches that one *thru* standard is used to connect one input portion and one output portion of one test fixture. The Examiner has not pointed to any disclosure that all combinations of ports in each test fixture are separately connected as pairs. Hence, Applicant submits that there are additional grounds for allowing claim 8.

In rejecting claim 12, the Examiner points to col. 8, lines 1-35 as providing the additional required teaching of optimizing a model using the measured results for each test fixture, the model representing one or more of the port-specific difference arrays, wherein optimizing comprises adjusting parameters of the model until a difference between test fixture measurements is minimized, the test fixture measurements being converted measurements of the second test fixture produced by the model using the measured results for the second test fixture and the measured results for the first test fixture, the model parameters representing the elements of the difference array. Applicant submits that the passage cited by the Examiner discusses computer models in a general way, offering no specific teachings regarding ports, difference arrays, optimization, or conversion between the two test fixtures. Hence, Applicant submits that there are additional grounds for allowing claim 12.

**E. Additional arguments for claims 14 and 29, which depend from claims 1 and 26 respectively**

In rejecting claims 14 and 29, the Examiner points to column 13, lines 51-62 of Dunsmore as providing the additional teaching required by these claims that solving for elements of the difference arrays comprises determining a complex square root of one of the

elements. Applicant submits that the passage in question relates to the use of the "least squares" metric, which is a mathematical technique of finding the "best fit" to a set of data by minimizing the sum of the squares of the differences between the fitted function (or model) and the data. The Claim limitation in question relates to finding a complex square root of one element in a difference array. The two mathematical operations are quite different. Hence, Applicant submits that there are additional grounds for allowing claims 14 and 29 and the Claims dependent therefrom.

**F. Rejection of claim 21 and the claims dependent therefrom**

In rejecting Claim 21, the Examiner points to Column 19, lines 16-47 of Dunsmore for the required teaching that the computer program comprises instructions that, when executed by the computer, implement determining a port-specific difference array that adjusts for a difference between a first test fixture and a second test fixture when each is used to interface the DUT for measurements. First, Applicant submits that the cited passage discusses programs and models in relation to a test fixture, but does not describe the use of any type of difference array. Second, the cited passage is silent about adjusting for any **difference between two test fixtures**. Hence, Applicant submits that Dunsmore does not anticipate claim 21 and the claims dependent therefrom.

Claim 22 additionally requires that the difference array is applied to correct or adjust the measured performance of the DUT, such that the DUT performance is measured using the second test fixture that approximates a hypothetical DUT performance as if measured using the first test fixture to interface the DUT to the test equipment. The passage at Column 19, lines 16-47 cited by the Examiner discusses programs and models in relation to a test fixture, but does not teach correction or adjusting of the type required by this claim. Hence, Applicant submits that there are additional grounds for allowing claim 22 and the claims dependent therefrom.

Claim 23 additionally requires that the difference array is applied directly to the DUT measurements to transform the measured DUT performance into the hypothetical DUT performance. The Examiner points to column 7, lines 55-67 and column 8, lines 22-40 of Dunsmore for these teachings. Applicant submits that the cited passages describe model selection in a general way but are silent with respect to the specific transformation required by

the limitations of this claim. Hence, Applicant submits that there are additional grounds for allowing claim 23.

Claim 24 additionally requires that the difference array is applied to a calibration of the test equipment to correct calibration coefficients of the test equipment, such that the measured performance of the DUT is equivalent to the hypothetical DUT performance. As noted above with respect to claim 23, the passages cited by the Examiner as providing these teachings describe model selection in a general way but are silent with respect to the specific transformation required by the limitations of this claim. Hence, Applicant submits that there are additional grounds for allowing claim 24.

Claim 25 additionally requires that the computer program comprises instructions that implement determining a complex square root of an element of the difference array using values of the element at a plurality of frequencies. The Examiner points to Column 13, lines 51-62 of Dunsmore as providing this teaching. As noted above with respect to claim 14, Applicant submits that the passage in question relates to the use of the "least squares" metric, which is a mathematical technique of finding the "best fit" to a set of data by minimizing the sum of the squares of the differences between the fitted function (or model) and the data. The claim limitation in question relates to finding a complex square root of one element in a difference array. The two mathematical operations are quite different. Hence, Applicant submits that there are additional grounds for allowing claim 25.

## VIII. CONCLUSION

Appellants respectfully submit that for the reasons of fact and law argued herein, the decision of the Examiner in finally rejecting Claims 1-14 and 21-31 should be reversed.

Respectfully Submitted,

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# APPENDIX

**THE CLAIMS ON APPEAL:**

1. A method of transforming measurements of a device under test (DUT) produced by a test system, the method comprising:

   determining a port-specific difference array, the difference array describing a difference between a first test fixture and a second test fixture at a corresponding test port of the test fixtures;

   measuring a performance of the DUT using the test system, wherein the DUT is mounted in the second test fixture; and

   applying the port-specific difference array, such that the measured DUT performance approximates a hypothetical DUT performance for the DUT mounted in the first test fixture and measured with the test system.

2. The method of transforming measurements of Claim 1, wherein the determined port-specific difference array is an error adaptor that is applied to the measured performance of the DUT to essentially remove an effect of a port portion of the second test fixture and to add an effect of a corresponding port portion of the first test fixture on the measured performance.

3. The method of transforming measurements of Claim 1, wherein determining a port-specific difference array comprises:

   measuring characteristics of a set of calibration standards at corresponding ports of the first test fixture and the second test fixture by separately inserting each calibration standards of the set in each test fixture at a respective port; and

solving for elements of the difference array using results obtained from measuring characteristics of the calibration standard set for each test fixture.

4. The method of transforming measurements of Claim 1, wherein applying the difference array to the measured performance of the DUT directly transforms the measured DUT performance into the approximation of the hypothetical performance.

5. The method of transforming measurements of Claim 1, wherein applying the difference array modifies a calibration of a test system, such that the measured performance of the DUT produced using the test system is the hypothetical measured performance.

6. The method of transforming measurements of Claim 1, wherein a performance of one or both of the first test fixture and the second test fixture and a performance of one or more calibration standards of the set used in determining the port-specific difference array are unknown or poorly known.

7. The method of transforming measurements of Claim 1, wherein determining employs measurements of the test fixtures at a plurality of frequencies in a frequency range of interest for the DUT.

8.The method of transforming measurements of Claim 3, wherein the calibration standards of the set connect corresponding pairs of ports to one another for each test fixture, such that all combinations of ports in each test fixture are separately connected as pairs for measuring the characteristics.

9. The method of transforming measurements of Claim 3, wherein measuring comprises:

measuring a reflection parameter of each standard of the set of calibration standards separately for each port of the first test fixture; and

measuring a reflection parameter of each standard of the set of calibration standards separately for each corresponding port of the second test fixture.

wherein one or more of the standards of the set isolate the respective port from other ports of the respective test fixture.

10. The method of transforming measurements of Claim 3, wherein measuring comprises:

measuring S-parameters for each standard of the set of calibration standards separately for each port pair of the first test fixture; and

measuring S-parameters for each standard of the set of calibration standards separately for each port pair of the second test fixture;

wherein the standards of the set are thru standards that connect pairs of ports together to form the port pairs.

11. The method of transforming measurements of Claim 3, wherein solving for elements comprises:

solving several equations for several unknowns using the measured results, the solved unknowns representing the difference array elements.

12. The method of transforming measurements of Claim 3, wherein solving for elements comprises:

optimizing a model using the measured results for each test fixture, the model representing one or more of the port-specific difference arrays, wherein optimizing comprises adjusting parameters of the model until a difference between test fixture measurements is minimized, the test fixture measurements being converted measurements of the second test fixture produced by the model using the measured results for the second test fixture and the measured results for the first test fixture, the model parameters representing the elements of the difference array.

13. The method of transforming measurements of Claim 3, wherein measuring and solving are repeated for each port or each pair of ports of each of the test fixtures.

14. The method of transforming measurements of Claim 3, wherein solving for elements of the difference arrays comprises determining a complex square root of one of the elements, wherein the square root is determined using data representing the element at more than one frequency.

21. A test system that measures a device under test (DUT) using different test fixtures comprising:

test equipment

a test fixture that interfaces the DUT to the test equipment;

a computer connected to receive and process data from the test equipment; and

a computer program executed by the computer, the computer program comprising instructions that, when executed by the computer, implement determining a port-specific difference array that adjusts for a difference between a first test fixture and a second test fixture when each is used to interface the DUT for measurements.

22. The test system of Claim 21, wherein the computer program further comprises instructions that implement measuring a performance of the DUT when the DUT is connected to the test equipment using the second test fixture; and instructions that implement applying the difference array to correct or adjust the measured performance of the DUT, such that the DUT performance measured using the second test fixture approximates a hypothetical DUT performance as if measured using the first test fixture to interface the DUT to the test equipment.

23. The test system of Claim 22, wherein the instructions that implement applying comprise applying the difference array directly to the measured performance of the DUT

produced by the test system to transform the measured DUT performance into the hypothetical DUT performance.

24. The test system of Claim 22, wherein the instructions that implement applying comprise applying the difference array to a calibration of the test equipment to correct calibration coefficients of the test equipment, such that the measured performance of the DUT is equivalent to the hypothetical DUT performance.

25. The test system of Claim 21, wherein the computer program further comprises instructions that implement determining a complex square root of an element of the difference array using values of the element at a plurality of frequencies.

26. A method of matching measurements of a device under test (DUT) in a second test fixture to hypothetical measurements of the DUT in a first test fixture using a test system, the method comprising:

determining a port-specific difference array, the difference array describing a difference between the first test fixture and the second test fixture at a corresponding test port of the test fixtures, wherein an element of the difference arrays is determined using measurements of a set of calibration standards in the test fixtures, the measurements being performed at a plurality of frequencies with the test system.

27. The method of matching measurements of Claim 26, further comprising:

measuring a performance of the DUT using the test system, wherein the DUT is mounted in the second test fixture; and

applying the port-specific difference array to measurements of the DUT mounted in the second test fixture to transform the measurements into measurements that match the hypothetical measurements of the DUT in the first test fixture.

28. The method of matching measurements of Claim 26, wherein the element is determined by optimizing a model across the plurality of frequencies using the calibration standard measurements.

29. The method of matching measurements of Claim 26, wherein the element is determined from a complex square root of a term of a port-specific error adaptor determined from the calibration standard measurements, the complex square root being computed using a plurality of values of the error adaptor term that corresponds to the plurality of frequencies.

30. The method of matching measurements of Claim 29, wherein computing the complex square root comprises:

unwrapping a phase portion of data points representing the element at different frequencies to produce phase-unwrapped data points;

dividing a wrap-normalized phase of the data points by two to yield a phase portion of the square root; and

computing a positive real-valued square root of magnitudes of the data points to produce a magnitude portion of the square root.

31. The method of matching measurements of Claim 30, further comprising before dividing a wrap-normalized phase:

estimating a group delay of the phase-unwrapped data points;

removing from the phase portion of the phase-unwrapped data points a number of complete phase wraps associated with a first data point to produce data points having the wrap-normalized phase, the number of complete phase wraps being computed using the estimated group delay.

**Evidence Appendix**

**none**

**Related Proceedings Appendix**

**none**